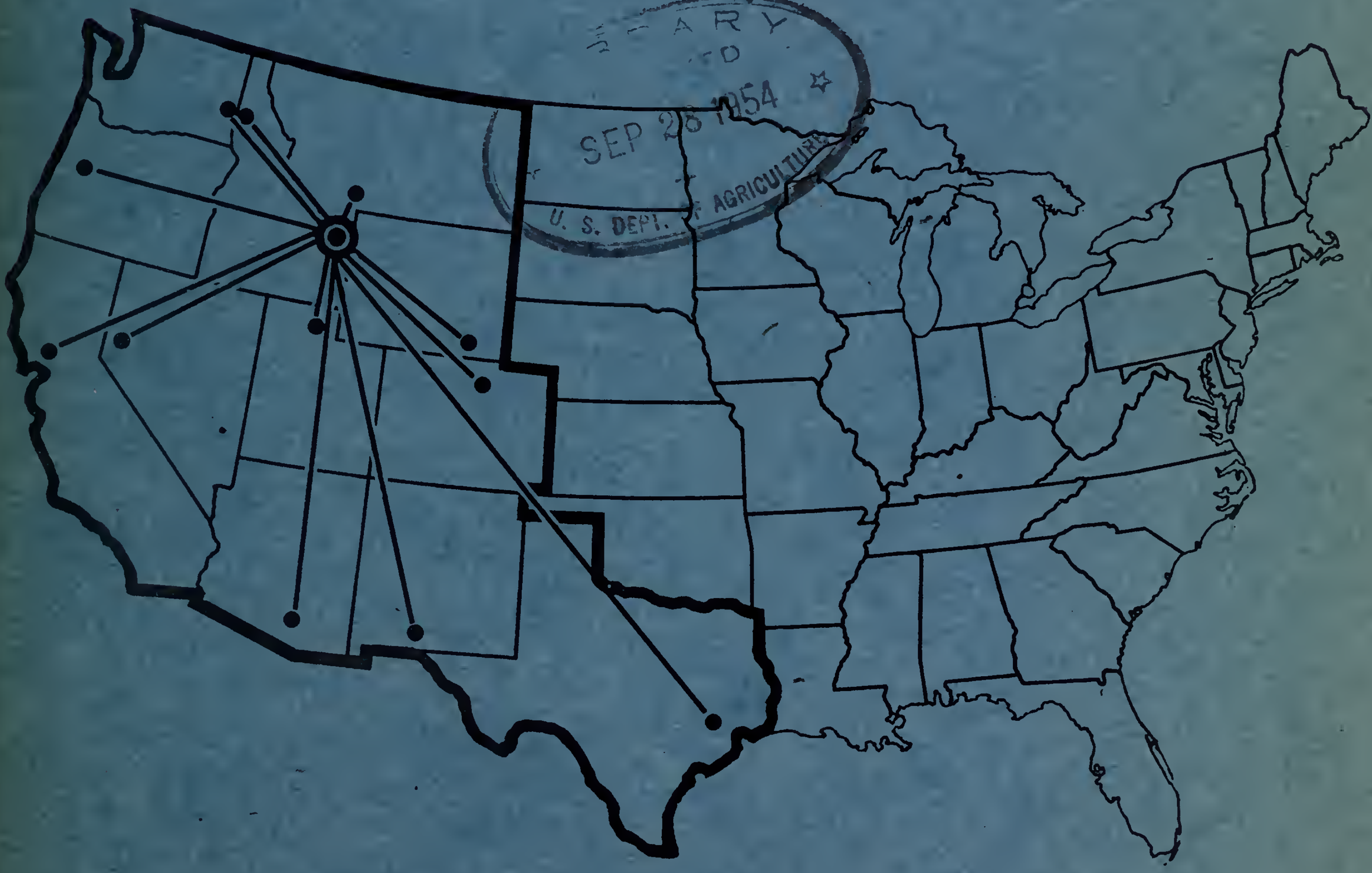
UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH ADMINISTRATION
BUREAU OF ANIMAL INDUSTRY
AND COOPERATING STATES

NINTH ANNUAL REPORT OF THE

WESTERN SHEEP BREEDING LABORATORY

DUBOIS, IDAHO

JUNE 30, 1946



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ANNUAL REPORT
Western Sheep Breeding Laboratory
June 30, 1946

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HONOR ROLL

Lt. (jg) L. Otis Emik	Naval Medical Research Unit #2 & NavTechJap, Atomic Bomb Team c/o P.M. San Francisco, California Returned to duty May 1, 1946
Lt. (jg) Henry R. Keller	SS Conrad Kohrs, Armed Guard Center (Pacific) Treasure Island, c/o F.P.O. San Farncisco, California Returned to duty April 1, 1946
Elroy M. Pohle, SP (P) 2/c	EXOS Microfilm Service 1526--14th Street, N. W. Washington, D. C. Returned to duty February 20, 1946
Capt. Chester F. Schaefer	01846062, 1159th AAF Base Unit A. P. O. #877, c/o P. M. Miami, Florida Returned to duty June 3, 1946
Sgt. George M. Sidwell	39828554, 137th Sta. Hospital, A. P. O. #246, c/o P. M. San Francisco, California Returned to duty February 18, 1946
Sgt. Lowell O. Wilson	19136415, 36th Photo Recon. Squadron A. P. O. #74, c/o P. M. San Francisco, California Returned to duty February 19, 1946

DIRECTORS OF STATE AGRICULTURAL EXPERIMENT STATIONS
OF THE TWELVE WESTERN STATES THAT ARE COLLABORATING
WITH THE WESTERN SHEEP BREEDING LABORATORY

ARIZONA:	P. S. Burgess, University of Arizona, Tucson.
CALIFORNIA:	C. B. Hutchison, University of California, Berkeley.
COLORADO:	H. J. Henney, Colorado State Agricultural College, Fort Collins.
IDAHO:	C. W. Hickman, Acting Director, University of Idaho, Moscow.
MONTANA:	Clyde McKee, Montana State College, Bozeman.
NEVADA:	S. B. Doten, University of Nevada, Reno.
NEW MEXICO:	A. S. Curry, Acting Director, New Mexico State College of Agriculture, State College.
OREGON:	W. A. Schoenfeld, Oregon State College, Corvallis.
TEXAS:	C. H. McDowell, Acting Director, Agricultural and Mechanical College of Texas, College Station.
UTAH:	R. H. Walker, Utah State Agricultural College, Logan.
WASHINGTON:	E. C. Johnson, Washington State College, Pullman.
WYOMING:	J. A. Hill, University of Wyoming, Laramie.

COLLABORATORS OF THE WESTERN SHEEP BREEDING LABORATORY

ARIZONA:	Ernest B. Stanley, Head, Department of Animal Husbandry, College of Agriculture, University of Arizona, Tucson.
CALIFORNIA:	James F. Wilson, Division of Animal Industry, College of Agriculture, University of California, Davis.
COLORADO:	A. Lamar Esplin, Department of Animal Husbandry, Colorado State College of Agriculture and Mechanic Arts, Fort Collins.
IDAHO:	C. W. Hickman, Head, Department of Animal Husbandry, College of Agriculture, University of Idaho, Moscow.
MONTANA:	Richard T. Clark, Head, Department of Animal Husbandry, Montana State College, Bozeman.
NEVADA	Charles E. Fleming, Department of Range Management, College of Agriculture, University of Nevada, Reno.
NEW MEXICO:	Philip E. Neale, Department of Animal Husbandry, New Mexico College of Agriculture and Mechanic Arts, State College.
OREGON:	Ray G. Johnson, Head, Department of Animal Husbandry, Oregon State Agricultural College, Corvallis.
TEXAS	Bruce L. Warwick, Department of Animal Industry, Texas Agricultural Experiment Station, College Station.
UTAH:	Louis L. Madsen, Head, Department of Animal Husbandry, Utah State College, Logan.
WASHINGTON:	M. E. Ensminger, Head, Department of Animal Husbandry, State College of Washington, Pullman.
WYOMING:	Fred S. Hultz, Head, Department of Animal Production, College of Agriculture, University of Wyoming, Laramie.

ROSTER OF PERSONNEL

WESTERN SHEEP BREEDING LABORATORY AND U. S. SHEEP EXPERIMENT STATION
Dubois, Idaho, as of June 30, 1946

Name	Rating	Date entered on duty	General Duties
Nordby, Julius E.,	Animal Husbandman P-6	March 1, 1938	Director
Terrill, Dr. Clair E.,	Animal Husbandman P-5	July 3, 1936	Geneticist, Physiologist
Stoehr, John A.	Animal Husbandman P-4	Aug. 28, 1928	Operations
Pohle, Elroy M.	Animal Fiber Technologist, P-3	May 2, 1938	Wool Technologist
Emik, Dr. L. Otis,	Animal Husbandman P-3	July 7, 1941	Assistant, Physiology and Genetics
Sidwell, George M.,	Animal Husbandman P-2	July 1, 1941	Assistant, Physiology and Genetics
Keller, Henry R.,	Animal Husbandman P-2	Oct. 16, 1941	Assistant, Wool laboratory
*Wilson, Lowell O.,	Scientific Aid SP-4	July 1, 1943	Assistant, Wool laboratory
Sidlinger, Henry M.,	Administrative Asst., CAF-7	June 1, 1945	Administrative Assistant
Schaefer, Chester F.,	Clerk, CAF-3	June 22, 1936	Clerk
**Hensley, Gladys L.,	Clerk-Typist CAF-3	April 2, 1945	Clerk-Typist
*Taylor, Jessie S.,	Clerk-Typist CAF-2	May 29, 1945	Clerk-Typist
**Harmon, Bennie D.	Clerk, CAF-2	April 1, 1946	Clerk
**Laird, M. Jean	Clerk, CAF-2	Jan. 14, 1946	Clerk
Jeffery, Lee C.,	Foreman of Farm Laborers, CPC-6	June 7, 1924	General maintenance pumps, equipment
Rasmussen, Henry, Jr.,	Farm Laborer CPC-6	July 1, 1926	Farm Laborer
Hohman, Max E.,	Farm Laborer CPC-4	April 1, 1935	Shepherd
Landacre, Harold E.,	Farm Laborer CPC-4	April 6, 1939	Truck driver, general maintenance
Goldman, James R.,	Farm Laborer CPC-4	May 1, 1939	Shepherd
*Howard, John H.,	Farm Laborer CPC-4	Oct. 2, 1944	Shepherd
*Walker, Raymond,	Farm Laborer CPC-4	April 6, 1944	Shepherd & Camp Tender

Phillips, Walter H.,	Farm Laborer CPC-4	March 16, 1935	Truck Driver
Powell, Fred A.,	Farm Laborer CPC-4	May 11, 1935	Teamster
*Waymire, Isom	Farm Laborer CPC-4	Oct. 1, 1945	Shepherd
Maloney, George	Farm Laborer CPC-4	June 10, 1946 (Reinstated)	Farm Laborer
**Gibbs, John H.,	Farm Laborer CPC-4	Oct. 3, 1945	Farm Laborer
**Swink, Albert B.,	Farm Laborer CPC-4	May 31, 1946	Shepherd & Farm Laborer
**Larson, John T. Jr.,	Farm Laborer CPC-4	June 10, 1946	Farm Laborer
Nantz, Dorinda R.,	Unskilled Laborer	June 16, 1941	Janitress & Cook

* Employees on War Service Appointments.

** Employees on Temporary Appointments.

FOREWORD

The annual report of the Western Sheep Breeding Laboratory will henceforth be prepared separately and not in conjunction with the annual report of the U. S. Sheep Experiment Station as heretofore except for data that can not be logically separated.

This rearrangement is necessary in the interest of the administration of the funds involved.

OBJECTIVE

The main objective of this Laboratory is to improve sheep for lamb and wool production under range conditions. In the pursuit of this objective basic breeding methods are employed; heritability analyses are made of the various utility factors, and the selection of breeding animals is based upon production as that is measured under range environment. Emphasis is placed primarily on the quantity and quality of lambs produced; the length, quality and quantity of clean scoured wool, and upon the adaptability and longevity of the sheep.

RESEARCH LINE PROJECTS

1. Development of systems of breeding for locating strains of Rambouillet sheep which may possess combinations of genes that will improve strains with which they may be crossed. This research line project includes:

    (a) The development of inbred strains or lines by the mating of animals as closely related as possible or desirable, and with emphasis on selection for all characters of economic importance.
    (b) The development of inbred lines with special reference to very important characters that are of economic importance to range sheep, such as mutton form, length of staple, and faces that are free from excess wool covering causing wool blindness.

2. Determination of the inheritance of various undesirable characteristics of Rambouillet sheep, such as abnormalities in the growth of wool, hairiness in fleeces of wool and excessive skin folds or wrinkles, for the purpose of developing methods of breeding by which these undesirable characteristics may be eliminated from the stock.

3. Studies in the physiology of reproduction of Rambouillet sheep as they may contribute to the program of the Western Sheep Breeding Laboratory, including

    (a) Sexual maturity of Rambouillet ram lambs.
    (b) Quality of semen in relation to fertility, and
    (c) Factors affecting fertility of ewes.

4. Studies in the physiology of wool production of Rambouillet sheep including reference to fiber uniformity within and between various regions of the fleece in relation to the total uniformity of the fleece.

5. Analysis of records of the characteristics of sheep and wool to determine the usefulness of such records in the program of the Western Sheep Breeding Laboratory.

CHANGE AND RESEARCH

Change is the pulse of progress,--the inevitable, unavoidable characteristic of a progressive civilization. There is change in the clothes we wear, in the food we eat, in the things we use, in the crops we grow. Change is evident in domestic and world markets, in industry, in communication, in materials which industry demands,--accelerated change everywhere. It is the natural corollary of free enterprise.

We are warned now that the advanced technologies of today will presently activate peacetime industry far beyond any dreams of a decade ago; also that this activation will be evident not only in our own country but it will leaven industry in all industrial countries and most assuredly will extend the frontiers of industry into some countries now relatively inactive in industrial enterprise. This war with its extended ramifications into almost every known area of the globe may also tend to cosmopolitanize industry and the consumption of its products.

Accelerated change in kind, quantity and quality of merchandise, however, is generally paralleled by the need for basic readjustment in the production and marketing economy of staple products which the new merchandise is in part designed to replace, and any industry that does not keep attuned to the basic economic needs may court disaster.

The application of science to industry is the fundamental safeguard against obsolescence and disaster in industry in this period of unprecedented stimulation and change. And industry is pushing forward on every front with a veritable army of research staffs, eagerly searching for more basic facts which control the behavior of materials or energy and which, when creatively applied, yield new merchandise that may be of greater value or be more salable, or both. Industry is also paralleling this type of research activity with researches in applied production and marketing economics.

The transition in industry will also be felt in agriculture. It may be keenly felt in the economics of agriculture and in rural life. Some of the inevitable changes will be pleasant; others will be very challenging. Still other changes may be fully as threatening to agriculture as they will be to industry or to those phases or individuals in agriculture and industry that permit orthodoxy to impede the forward march with change for basic improvement in the economics of the products involved.

In our western agriculture, we cannot overlook the impact which synthetics manufactured from wood pulp, casein, peanut hulls, soy beans, and other sources of fiber may have upon wool,--sources which are also of the soil. The range sheep industry will not be overlooked by change in a revamped foreign and domestic industry and agriculture in its need for adjustment, and the more directly or

indirectly the products of the soil such as wood pulp, casein, and plant fibers become essential in the production of substitutes which will replace staple products of the soil, the more challenging the change becomes.

Organized research in the fundamentals of any productive activity is designed to guide man into new ways of doing things which he can no longer do the way he is doing them now. Fundamental research is the search for truth. One of its applications is to make old or new products fit more efficiently into a changing economy. This applies to agriculture as well as to industry. To the degree in which research is successful, it adds economic stability to industry and agriculture. Research is constantly challenging empirical methods,-- the conventional way of doing things. And all of the burden of proof in a progressive civilization does not lie with the research worker who is exploring new methods. The burden of proof rests as well with the person who assumes that the empirical, the old established method, is adequate in meeting new demands--demands that are predicated upon a revamped economy. Sheepmen are part of a civilization characterized by change, and no empirical and established system of breeding, feeding, management or marketing can possibly lay claim to immortality.

As research in basic principles of materials, energy, and competitive economy is the catalyst, the truth-searching forerunner of change in industry, so must research in the basic principles of biological realities and in economic truths be the forerunner of change in the improvement of domestic animals and in the marketing of their products. The day of spectacular advances in fundamental improvement of conventional methods applied to animal improvement is quite clearly gone. Production of wool and lamb per unit has now reached a relatively high point, and the higher production goes, the more difficult it is to make spectacular improvement in range sheep production per unit. But conservative improvement will progressively yield its reward in contributing stability to a changing economy. It appears, henceforth, that progress in the economic value of domestic animals will not be made by a few brilliant manipulations of chance procedure of courageous individuals, but rather by well-organized efforts of research workers pushing forward on many fronts, the same as in industry, and by the full cooperation of producers in the field activating into production the advances that research yields.

Sheep have a dual role in the economy of western agriculture, namely, the production of meat and wool. As the topography, temperature and feed conditions vary, there are corresponding variations in the emphasis on meat and wool production. In areas of relatively good feed conditions, the income from meat is somewhat higher than the income from wool. In sparcer feed areas the income from wool approaches and may exceed the income from meat. These, in general, are the conditions that have prevailed for some time. It does not necessarily follow that the same ratio of income will continue to prevail in years to come in the respective areas where feed conditions may remain in general the same. Wool and meat are not both subject to influence by the same competitive enterprises. Now is it likely that the

political idiosyncrasies of man and his clothing and diet habits will insure a status quo in the present income ration of wool and meat in the industry. For instance, if the agencies that create fashions in clothing receive enough encouragement from the manufacturers and salesmen of synthetic fiber material, and the supply of this material moves into trade channels at an ever accelerated rate, it is not so difficult to see how the consuming public may directly influence the present proportion of income from wool and meat in the sheep ranching industry.

The over-all situation may appear somewhat insecure for the wool producing industry. But, competition stimulates salesmanship. It stimulates inquiry into basic production economies. It stimulates inquiry into marketing economies. And, out of the sum total of these inquiries and the application of discoveries arising from them will also arise the new economies upon which competitive change is predicated. And, if we were to be very frank, perhaps we would be tempted to say that it is difficult to see how, with our sincere appreciation of the problems ahead, we can do otherwise than give our full and unbiased support to fundamental research efforts and to the application of basic gains that accrue to the industry through research.

The research worker is a human being. He is subject to influences that often divert the course of fundamental research problems onto detours that generally work out to be blind alleys. In working with domestic animals we are all tempted, no doubt in large part, because we thoroughly enjoy to look at those that conform to a pleasing pattern, to lay too much emphasis upon the outward pattern. In fact we may even accept that as the result of research. Whereas, it may not be the result of basic research at all. It may be the result of the chance introduction of a sire that nicks well with the females at hand and a lot of good feed. Or, it may be the result of the introduction into a flock of a relatively large group of selected females from various top herds which has resulted in maximum heterosis and often a few very good looking progeny. But this is not research unless we are using it as a means of searching for genes which we can later systematically combine into a purified creation for production genes,--and that is a long story, but one that is fruitful of much research effort. Research must go beyond those empirical practices that are common commercial practices. Research always goes beyond the empirical in industry. If it does not, it is not research. Likewise, the person who is employed to do research in basic animal improvement must go beyond the orthodox. And he must constantly discipline himself to recognize unfruitful detours which are, no doubt, the most disturbing elements he has to encounter.

The period of change in which we now find ourselves is rushing in upon us with new accelerated demands. However, it is difficult to accelerate basic breeding work. It moves slowly. And this is a prime reason for avoiding detours,--for moving along paths of progress that can be charted with reasonable clarity with clear thinking and full use of basic biological and economic information.

PUBLICATIONS

The following papers have been published or mimeographed since the beginning of the Western Sheep Breeding Laboratory in 1937. The complete list is included again this year because the reports of the Western Sheep Breeding Laboratory and U. S. Sheep Experiment Station are presented separately this year. Only the publications contributed to by the Western Sheep Breeding Laboratory are included in this list. Those publications which were also contributed to by the U. S. Sheep Experiment Station are starred. A number of contributions have been made to livestock journals and the general press that are not included in this series. They are for the most part adaptations of the regular series but rewritten for the lay reader.

5. Reproductive Capacity of Rambouillet Ram Lambs as Indicated by Semen Tests. C. E. Terrill, Proc. of the Amer. Soc. of An. Prod., 1938, pp. 308-310.

* 6. A Preliminary Study of the Relation Between Fleece Characteristics of Weanling and Yearling Range Sheep. W. V. Lambert, J. I. Hardy and R. G. Schott, Proc. of the Amer. Soc. of An. Prod., 1938, pp. 298-303.

* 7. Reproduction in Range Sheep. C. E. Terrill and John A. Stoehr, Proc. of the Amer. Soc. of An. Prod., 1939, pp. 369-375.

* 8. Selection of Range Rambouillet Ewes, C. E. Terrill, Proc. of the Amer. Soc. of An. Prod., 1939, pp. 333-340.

* 9. Comparison of the Accuracy of Two Methods of Estimating Fineness of Wool Fibers. Ralph W. Phillips, R. G. Schott, J. I. Hardy and H. W. Wolf, Jour. of Agr. Res. 60(5):343-350, Mar. 1, 1940.

* 11. The Western Sheep Breeding Laboratory and U. S. Sheep Experiment Station. Julius E. Nordby, Extension Animal Husbandman, Sept., 1940.

12. Genetics and Range Sheep Improvement. Julius E. Nordby, Scientific Monthly 51:310-320, Oct., 1940.

* 14. The Application of a Rapid Comparator Method for Determining Fineness and Variability in Wool. Elroy M. Pohle, Proc. of the Amer. Soc. of An. Prod., 1940, pp. 161-168.

* 16. Growth in Corriedale and Rambouillet Sheep under Range Conditions. Ralph W. Phillips, John A. Stoehr and G. W. Brier, Proc. of the Amer. Soc. of An. Prod., 1940, pp. 173-181.

* 17. Sheep Improvement for Range Production. Julius E. Nordby, Idaho Forester 23, 1941, Forestry School, University of Idaho.

18. A Rapid Method for Expressing Medullation in Wool. Elroy M. Pohle, A.H.D. No. 41, May 1941, 6 pp. (Processed).

21. Face Covering in Range Sheep. Clair E. Terrill. A.H.D. No. 49, Nov., 1941, 9 pp. (Processed).

* 22. Wool Yield Determination in which Small Samples are Compared with Whole Fleeces. Ralph G. Schott, Elroy M. Pohle, Damon A. Spencer, and Glenn W. Brier, A.H.D. No. 50, Jan., 1942, 6 pp. (Processed).

* 23. Wool Yields in the Small Side-Sample as Related to Individual Whole Fleece Yields in Form Breed-Groups of Sheep. Ralph G. Schott, Elroy M. Pohle, Damon A. Spencer and Glenn W. Brier, Jour. of An. Sci. 1(2):137-144, May 1942.

* 24. The Importance of Body Weight in Selection of Range Ewes. Clair E. Terrill and John A. Stoehr, Jour. of An. Sci. 1(3):221-228, Aug., 1942.

* 25. Relationship Between Weanling and Yearling Fleece Characters in Range Sheep, Elroy M. Pohle, Jour. of An. Sci. 1(3):229-235, Aug. 1942.

* 26. Staple Length in Relation to Wool Production. Elroy M. Pohle and Henry R. Keller, Jour. of An. Sci. 2(1):33-41, Feb., 1943.

27. Improving Rambouillet Sheep for Western Ranges. Julius E. Nordby, National Wool Grower 33(3):12-7, Mar., 1943.

* 28. Staple Length and Its Influence on Shrinkage and Fleece Values. Elroy M. Pohle and Henry R. Keller, National Wool Grower 33(6):22-24, June, 1943.

30. Sampling and Measuring Methods for Determining Fineness and Uniformity in Wool. Elroy M. Pohle, L. N. Hazel and H. R. Keller, U.S.D.A. Cir. 704, 14 pp., Aug., 1944.

31. Wool Fineness in Eight Sampling Regions on Yearling Rambouillet Ewes. Elroy M. Pohle and R. G. Schott, Jour. of An. Sci. 2(3):197-208, Aug., 1943.

32. Clean Wool Yield Variation Among Regions of Rambouillet Fleeces. Elroy M. Pohle, H. W. Wolf and Clair E. Terrill, Jour. of An. Sci. 2(3):181-187, Aug., 1943.

33. Fiber Density and Some Methods of its Measurement in the Fleeces of Rambouillet Sheep. H. W. Wolf, W. M. Dawson and E. M. Pohle, Jour. of An. Sci. 2(3):188-196, Aug., 1943.

* 34. Estimation of Clean-Fleece Weight from Grease-Fleece Weight and Staple Length. Clair E. Terrill, Elroy M. Pohle, L. Otis Emik, and Lanoy N. Hazel, Jour. of Agr. Res. 70(1):1-10, Jan. 1, 1945.

* 35. Clean Wool Yields in Small Samples from Eight Body Regions as Related to Whole-Fleece Yields in Four Breeds of Sheep. Elroy M. Pohle and L. N. Hazel, Jour. of An. Sci. 3(2):159-165, May, 1944.

* 36. Shrinkage and Value by Grades for 1943 Range Wool. Elroy M. Pohle and Henry R. Keller. National Wool Grower 34(6):22-23, June, 1944. (Published in other Wool Growers Magazines)

* 39. Monthly Changes in Fineness, Variability and Medullation in Hairy Lambs. Elroy M. Pohle, H. R. Keller and L. N. Hazel, Jour. of An. Sci. 4(1):37-46, Feb., 1945.

40. More Profit in Open Face Ewes. Clair E. Terrill, Mont. Wool Grower 18(1):13, 47, Jan., 1944. (Published in other Wool Growers Magazines).

* 41. The Influence of Location and Size of Sample in Predicting Whole-Fleece Clean Yields. E. M. Pohle, L. N. Hazel and H. R. Keller. Jour. of An. Sci. 4(2):104-112, May, 1945.

* 42. Wool Off-Sorts, Percentage, Shrink, Value. Elroy M. Pohle and Henry R. Keller. Montana Wool Grower 18(6):7, June, 1944. (Published in other Wool Growers Magazines).

43. Effectiveness of Selection on Progeny Performance as a Supplement to Earlier Culling in Livestock. G. E. Dickerson and L. N. Hazel, Jour. of Agr. Res. 69(12):459-476, Dec. 15, 1944.

* 44. Looking Forward, The Stabilizing Influence of Research in a Changing Sheep Production Economy. Julius E. Nordby, National Wool Grower 35(6):18-19, 35-36, June, 1945.

45. The Etiology and Inheritance of Inequalities in the Jaws of Sheep. Julius E. Nordby, Clair E. Terrill, Lanoy N. Hazel, and John A. Stoehr. Anat. Rec. 92(3):235-254, July, 1945.

46. Effects of Some Environmental Factors on Weanling Traits of Range Rambouillet Lambs. L. N. Hazel and Clair E. Terrill. Jour. of An. Sci. 4(4):331-341, Nov., 1945.

47. Heritability of Weaning Weight and Staple Length in Range Rambouillet Lambs as Evaluated by Scoring, L. N. Hazel and Clair E. Terrill. Jour. of An. Sci. 4(4):347-358, Nov., 1945.

48. Heritability of Type and Condition in Range Rambouillet Lambs as Evaluated by Scoring. L. N. Hazel and Clair E. Terrill. Jour. of An. Sci. 5(1):55-61, Feb., 1946.

49. The Covariance Analysis of Multiple Classification Tables with Unequal Subclass Numbers. L. N. Hazel. Biometrics Bulletin 2 (2):21-25, April, 1946.

50. Heritability of Face Covering and Neck Folds in Range Rambouillet Lambs as Evaluated by Scoring. Clair E. Terrill and L. N. Hazel. Jour. An. Sci. 5(2):170-179, May, 1946.

53. Effects of Some Environmental Factors on Fleece and Body Characteristics of Range Rambouillet Yearling Ewes. L. N. Hazel and Clair E. Terrill, to appear in the Journal of Animal Science.

* 54. Length of Gestation in Range Sheep. Clair E. Terrill and L. N. Hazel. Submitted to the American Journal of Veterinary Research.

55. Refining Methods for Evaluating Semen in the Prediction of Fertility of Rams. L. O. Emik and G. M. Sidwell, submitted to The Journal of Animal Science.

ABSTRACTS

The following abstracts have been published since the beginning of the Western Sheep Breeding Laboratory in 1937. Those which have also been contributed to by the U. S. Sheep Experiment Station are starred. These abstracts are in general of work that has been or will be published and listed in the regular series of publications.

* 1. Relationship Between Weanling and Yearling Fleece Characters in Range Sheep. Elroy M. Pohle, Jour. of An. Sci. 1(1):60, Feb. 1942.

* 2. The Importance of Body Weight in Selection of Range Ewes. Clair E. Terrill and John A. Stoehr, Jour. of An. Sci. 1(1):60-61, Feb., 1942.

3. Fineness of Fiber in Eight Sampling Areas on Yearling Rambouillet Ewes. Elroy M. Pohle and R. G. Schott, Jour. of An. Sci. 1(4): 356, Nov., 1942.

4. Clean Wool Yield Variation Among Regions of Rambouillet Fleeces Elroy M. Pohle, H. W. Wolf and Clair E. Terrill, Jour. of An. Sci. 1(4):356, 357, Nov., 1942.

* 5. Estimation of Clean Fleece Weight from Unscoured Fleece Weight and Staple Length. Clair E. Terrill, Elroy M. Pohle and L. Otis Emik, Jour. of An. Sci. 1(4):357, Nov., 1942.

6. A study of the Fiber Density of the Fleeces of Rambouillet Sheep. H. W. Wolf, W. M. Dawson and E. M. Pohle, Jour. of An. Sci. 1(4): 357-358, Nov., 1942.

7. Heritability of Yearling Fleece and Body Traits of Range Rambouillet Ewes. Clair E. Terrill and Lanoy N. Hazel, Jour. of An. Sci. 2(4):358-359, Nov., 1943.

* 9. Clean Wool Yields in Small Samples from Eight Body Regions as Related to Whole-Fleece Yields in Four Breeds of Sheep. Elroy M. Pohle and L. N. Hazel, Jour. of An. Sci. 2(4):370, Nov., 1943.

10. Sampling and Measuring Methods for Determining Fineness and Uniformity in Wool. Elroy M. Pohle, L. N. Hazel and H. R. Keller, Jour. of An. Sci. 2(4):371, Nov., 1943.

11. Effects of Some Environmental Factors on the Weanling Traits of Range Sheep. L. N. Hazel and Clair E. Terrill, Jour. of An. Sci. 3(4):432, Nov., 1944.

* 12. The Gestation Period of Range Sheep. Clair E. Terrill, Jour. of An. Sci. 3(4):434-435, Nov., 1944.

* 13. The Influence of Location and Size of Sample in Predicting Whole-Fleece Clean Yield. Elroy M. Pohle and L. N. Hazel, Jour. of An. Sci. 3(4):452, Nov., 1944.

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SUMMARY OF RAMBOUILLET -- SPECIAL RESEARCH BREEDING
1945-46 Breeding Season

Pen no.	Ram no.	No. ewes	Face cov. score	Type score	Yearling body weight (lbs.)	Yearling adj. fleece weight (lbs.)	Yearling adj. fleece length (cms.)	Inbr. coef. of dams (%)	Age of ewes at lambing (years)
18	1646RW	23	4.88	2.16	81.00	8.32	6.25	12.87	4.13
19	1314RW	23	4.74	2.16	84.09	8.01	6.06	16.97	3.91
20	1198RW	31	4.70	2.05	89.58	9.00	6.52	11.33	3.74
21	1492RW	25	4.48	2.16	85.08	8.83	6.94	9.76	4.12
22	6061 W	29	4.43	2.17	92.45	9.36	6.54	10.08	3.55
23	1425RW	29	4.68	2.16	88.62	9.14	6.20	13.58	4.17
24	1807RW	34	4.83	2.21	88.18	8.98	6.61	17.14	3.97
25	5950 W	31	4.51	2.03	90.58	8.65	6.91	4.56	4.10
26	5639 W	30	4.73	2.27	90.17	9.20	6.25	3.35	4.77
27	1719RW	30	4.59	2.19	89.60	8.70	6.10	14.35	4.53
28	6937 W	30	4.61	2.07	94.23	9.35	6.04	4.66	4.47
29	5813 W	30	4.68	1.98	94.30	9.10	6.80	3.37	3.17
32	1447RW	39	4.82	2.24	85.56	8.95	6.35	11.49	4.38
34	1480RW	27	4.64	2.15	88.30	8.56	6.46	13.77	4.33
35	4728 W	30	4.36	2.27	93.10	8.37	6.20	5.46	4.40
36	4252 W	30	4.66	2.12	90.90	8.51	6.27	4.58	3.50
37	5587 W	31	4.73	2.09	85.90	8.89	6.97	11.94	3.87
39	5497 W	30	4.83	2.24	88.17	9.12	6.63	3.82	4.30
40	6752 W	30	3.48	2.18	92.17	8.76	6.25	7.41	3.53
42	6536 W	28	4.58	1.93	94.36	8.71	6.06	.26	4.07
43	6638 W	29	4.86	2.20	88.93	8.34	6.28	3.88	4.52
44	5935 W	29	4.61	2.13	90.34	9.10	6.25	4.67	3.97
45	5326 W	30	4.76	1.99	88.40	8.53	6.77	3.33	3.40
46	5915 W	31	4.75	2.01	90.48	8.94	6.44	3.48	3.74
47	6468 W	29	4.31	2.01	90.10	8.95	7.46	4.90	3.66
49	5546 W	30	4.52	2.07	94.33	8.70	6.28	1.73	3.57
50	5696 W	31	4.27	2.10	89.55	8.67	6.68	5.17	3.55
51	4666 W	30	4.33	2.09	90.77	9.08	6.48	4.50	3.97
53	5090 W	31	4.58	2.13	87.90	8.87	6.72	1.21	3.84
54	6328 W	30	4.42	2.01	92.23	8.92	6.61	.55	3.93
Average for all		890	4.58	2.12	89.63	8.83	6.49	7.08	3.97

PROGRESS OF INBRED LINES OF RAMBOUILLETS

Matings were made in 30 inbred lines during the year 1945-46. No lines were added or dropped during the year. The number of ewes were reduced from 962 to 890 because of increasing feed costs. In addition, a number of inbred ewes which had been used in test pens were also disposed of. A summary of the records of ewes in the Special Research breeding pens are given in the accompanying table.

Changes in inbreeding since the project was initiated are shown in the following table.

Year lambed	Potential inbred lines	Inbreeding coefficients in percent based on ewes bred: Sires	Dams	Progeny	Increase of progeny over dams	Highest for progeny of any pen	Highest for any individual offspring
1938	20	4.0	1.1	3.9	2.8	13.3	37.9
1939	22	7.5	3.2	7.2	4.0	30.3	58.3
1940	34	6.0	3.6	8.2	4.6	32.6	58.3
1941	36	3.3	2.7	8.6	5.9	31.2	47.3
1942	37	4.1	4.0	8.6	4.6	28.7	39.9
1943	30	4.4	4.2	8.9	4.7	23.0	36.9
1944	30	5.0	5.0	10.3	5.3	22.8	48.0
1945	30	6.0	5.8	14.2	8.4	26.8	42.5
Inbreeding coefficients in percent based on lambs weaned							
1938	20	4.1	1.2	3.2	2.0		
1939	22	6.6	3.3	4.9	1.6		
1940	34	5.8	2.1	7.2	5.1		
1941	36	3.1	2.5	6.6	4.1		
1942	37	4.3	2.9	7.5	4.6		
1943	30	4.2	3.1	7.6	4.5		
1944	30	5.0	4.1	9.5	5.4		
1945	30	5.3	4.7	12.4	7.7		

The average inbreeding coefficient of all lambs weaned in 1945 was 12.4 percent as compared with 3.2 percent in 1938. This represents an average increase of slightly more than one percent per year. The annual change for the offspring has increased in the last 2 years. The sires were slightly more inbred than the dams, on the average, probably because they are generally younger. In general the average inbreeding of the dams based on lambs weaned was less than that of dams based on ewes bred because the younger dams are more inbred and wean a lower proportion of lambs per ewe bred than older ewes.

Significant differences between lines have been found in offspring groups for each of the traits measured. It appears that already there is an apparent decrease in the variation within lines and an increase in the variation between lines as they become more inbred.

The first 6 lines for each of the more important traits are listed in the following table for comparison with similar tables presented in previous years. These pens were ranked on averages from weanling offspring in 1944.

Trait	1st	2nd	3rd	4th	5th	6th
Body weight	40	24	43	34	46	35
Body type	24	46	37	54	20	39
Condition	42	39	43	45	34	26
Staple length	45	47	21	20	37	24
Open face	40	44	20	50	28	35
Freedom from folds	45	37	21	23	47	32
Index	40	20	45	35	50	27

About two-thirds of the lines are included in the table. Twelve of these lines were included last year and 9 were not. Seven lines (21, 32, 34, 37, 40, 44, and 47) have ranked in the high six for one or more traits for each of the last 5 years.

The downward trend in the age of the ewes which has been underway since 1940 continued this year although the change was slight. The average age of the ewes was reduced from 4.01 years in 1944-45 to 3.97 years in 1945-46.

LAMB PRODUCTION OF RAMBOUILLET FLOCK

A summary of lamb production in the Rambouillet flock for the past 22 years is presented in the following table. The percent of ewes pregnant for 1945 was above average. The percent of lambs weaned was also above average although the lambing percent was slightly below average. The average weaning weight was the lowest for any of the last 6 years and consequently the pounds of lamb weaned per ewe bred were also definitely below average for 1945.

LAMB PRODUCTION OF RAMBOUILLET FLOCK

Year	No. of ewes bred	Percent of ewes pregnant	Percent of lambs born of ewes lambing	Percent of lambs weaned of ewes bred	Average weaning weight	Pounds of lamb per ewe bred
1924-29	1790	--	--	69.8	72.3	50.5
1930-39	2294	82.3	--	72.9	68.1	49.6
1940	805	87.9	122.0	86.5	79.1	68.4
1941	850	94.3	128.2	92.9	76.2	70.8
1942	1023	90.7	125.3	93.4	75.1	70.1
1943	903	88.0	124.9	91.6	83.4	76.4
1944	908	92.0	129.4	94.3	75.2	70.9
1945	962	91.7	123.4	92.2	69.8	64.3
1940-45	5451	90.8	125.6	91.9	76.3	70.1

RELATIONSHIPS AMONG RAMBOUILLET WEANLING TRAITS

The correlations between the various weanling traits were calculated from records taken on 2183 range rambouillet lambs. Adjustments were made for several known environmental factors and the adjusted correlations were compared to the actual ones. Genetic correlations involved the correlation between each trait and each other trait of relatives (half sisters and daughters or dams).

The correlations between weaning weight, body type and condition were highest, showing that size has a pronounced influence upon scores for body type and condition. Weaning weight was positively but not strongly related to length of staple and development of neck folds.

Length of staple was positively correlated with better type and condition, the coefficients being 0.36 and 0.24, respectively. The correlation between scores for condition and neck folds was -0.21 indicating that the lambs in highest condition tended to develop slightly more neck folds. Face covering was not closely related to any of the other traits.

The genetic correlation between staple length and weaning weight, insofar as it can be trusted in view of the uncertain size of its sampling error, was -0.26 indicating that the inherent relationship between staple length and weaning weight is negative. The genetic correlation between staple length and neck folds is of considerable interest because of the popular belief among sheep breeders that increased smoothness results in increased length of staple. The

negative genetic correlation between staple length and neck folds of -0.27 is not very high but it provides factual evidence for this belief. The genetic correlation between weaning weight and neck folds of -0.14 indicates that the positive correlation (actual) of 0.26 is entirely environmental.

PRELIMINARY NOTES ON RELATIVE ECONOMIC VALUES FOR TRAITS IN RAMBOUILLET LAMBS

The economic value of a trait represents the monetary value of a unit change in that trait. If cost of production is increased or decreased by a change of one unit, then cost of production should be subtracted or added in calculating economic value. For example, an increase of one pound in fleece weight does not change shearing costs but does increase freight charges on the wool clip.

Weaning Weight

The economic value of weaning weight is practically a direct function of market price minus freight rate under range conditions. Since charges are on a per head basis, a 90 pound lamb costs no more to produce than a 70 pound lamb. The heavier lamb, however, would cost more to get to market. The average market price has been taken as $.125 per pound and freight charges as $.013 per pound, giving weaning weight an economic value of $.112. The most important factor in assigning a value to weaning weight is the relative value of clean wool, because the ratio of the two values determines how much emphasis should be placed on lamb production as compared with wool production. Long time price averages for lambs and wool in the 1940 Agricultural Statistics show that one pound of clean wool in Boston is worth 8.9 pounds of lamb in Chicago. Because all of our lambs do not sell as fat lambs and because of a difference in freight rate, it seems that our ratio should be about 10 pounds of lamb to one of wool.

Staple Length

Staple length is the only satisfactory measure of future wool production which is available when weanling lambs are culled. We have 2 studies which indicate that the regression of yearling staple length on weanling length is about 1.0, meaning that an increase of one unit in weanling length represents an average increase of 1 unit in yearling length. We have 3 studies which indicate that an increase of 1 centimeter in yearling length is associated with an increase of about 1/2 pound in clean fleece weight at yearling age. One study indicates that ewes which produced staple 1 centimeter longer than average at yearling age had a lifetime staple length 0.61 centimeter longer than average. This difference of .5 lbs. in the yearling fleece

and .3 pound in each subsequent fleece is indicated for a 1 centimeter difference in weaning length. If ewes live on the average past their fourth birthday, 1 centimeter of difference in weanling staple length would mean 1.4 pounds more clean wool during the ewes lifetime. Since the value per clean pound increases slightly with staple length (perhaps \$.013) and ewes produce fleeces weighing about 4.5 pounds of clean wool, this means an added \$.01(4)(4.5) = \$.18 per ewe. Thus in dollars and cents 1 centimeter of weanling staple length on the weanling fleece means an increased value of \$.18 + 1.68 = \$1.86 per ewe. The cost of marketing the additional wool is about \$.14 so the economic value assigned staple length (per cm.) is \$1.72.

Face Covering

It has been found that open faced ewes produced both a higher percentage of lambs and slightly heavier lambs. These differences indicated that pounds of lambs weaned increased by about 4.3 pounds for each improvement of one unit in face score. Since ewes on the average stay in the flock 3 lambing years while they are in the flock, a unit change in face covering means a difference of 12.9 pounds of lamb weaned. At \$.112 per pound, this gives an economic value for face covering of \$1.44 per unit.

Neck Folds

It seems impossible to get a satisfactory method for calculating the economic value of neck folds at present. Feeders prefer smooth lambs to wrinkled ones but how much they are willing to pay for the difference is not known. A difference of \$2.00 per cwt. between our smoothest and most wrinkled lambs seems to be a fairly large difference to assume. This difference would amount to about 2 grades, and on lambs averaging 75 pounds at weaning, would mean that one unit less of neck folds should have an economic value of \$0.75. Are neck folds worth more than this, as compared to face covering which has a value of \$1.44? Smooth ewes are easier to shear and suffer less from cuts and flies than wrinkled ewes. From the standpoint of selling breeding animals one unit in neck folds may be worth as much as one unit in face covering or 1 centimeter in staple length. However, because our flock has already reached the level of smoothness where neck folds is not a serious problem, it seems logical that it should receive less attention than face covering. Hence, a tentative value of \$0.75, is suggested at present.

Type and Condition

The relative economic value of type and condition can be set within reasonable limits by the average range in market prices for the best and poorest lambs coming to market. The market range, at an average price of 12.50 per cwt. would not be over \$5.00 per cwt., or \$3.75 per head for lambs with an average weight of 75 pounds.

This seems likely to be an over-estimate but because type has advertising value as well as esthetic appeal, it seems better to overemphasize it rather than otherwise. If we divide the range of $3.75 by 4 scoring units as representing the extreme range in our lambs, we get $0.938. Since the range of $5.00 in market price represents extremes in both type and condition and the two are inextricably related it seems best to divide the $0.938 between the two, giving each an economic value of $0.47 for one scoring unit.

A SELECTION INDEX FOR RAMBOUILLET WEANLING LAMBS

A selection index is often essential in order to combine the values of several traits to obtain one value on which to select so that maximum gain in overall merit may be made. Such an index has been constructed by a multiple correlation method for Rambouillet weanling lambs. The following traits with their symbols were included:

Face covering	F
Length of staple	L
Weaning weight	W
Type score	T
Condition score	C
Neck folds	N

The following constants, obtained from weanling Rambouillet lambs, were used in constructing the index.

1. Relative economic values of the different traits: (Value of unit change in each trait in dollars)

F	$1.440
L	1.720
W	.112
T	0.470
C	0.470
N	0.750

2. Phenotypic constants:

   a. Standard deviations for each trait.

F	0.61
L	0.46
W	8.48
T	0.48
C	0.43
N	0.77

b. Correlation between each pair of traits

	F	L	W	T	C
L	.02				
W	-.05	.15			
T	.05	-.28	-.49		
C	.03	-.19	-.56	.47	
N	.12	-.12	.14	.12	-.16

3. Genetic constants
   a. Heritability of each trait

F------------.56
L------------.40
W------------.30
T------------.13
C------------.04
N------------.39

   b. Genetic correlations between each pair of traits:

	F	L	W	T	C
L	.08				
W	-.13	-.26			
T	-.03	-.37	-.38		
C	.06	.01	-.14	.61	
N	.13	-.27	-.14	.48	.01

The completed index (I), where the individual record for each trait is indicated by the symbol for that trait follows:

I = 75 - (15 x F) + (7 x L) + W + (0.4 x T) + (8 x C)-(11 x N)

The constant of 75 is added to insure that the index will be be positive and average around 100. Corrections for environmental factors may be made directly to the index by use of the following constants:

Twins ------------------------	+4.1
Twins raised as singles ------	+1.6
Two year old dams ------------	+2.1
Age ---------------------------	-(.34)(age in days - 135)
Inbreeding -------------------	+(.31)(Inbreeding coefficient in percent)

The completed indexes varied from about 70 to 150 for individual lambs with an average of about 110. The value of the index may be estimated by comparing the progress when the index was used with that before it was available. Progress was roughly determined by combining the selection differentials for the various traits after each was weighted by its heritability and its economic importance. It appears that overall progress from selection at weaning age was increased in the range of 20 to 50 percent by the use of a selection index.

SELECTION PRACTICED ON RAMBOUILLET LAMBS

Progress in breeding for improvement may be roughly estimated from the selection intensity which is actually obtained. Since considerable selection is accomplished at weaning age the selection differentials for Rambouillet weanling lambs in 1945 are presented in the following table:

		Face covering	Staple length	Weaning weight	Type	Condi- tion	Neck folds
		score	cm.	pounds	score	score	score
Rams	Advantage of selected lambs	.24	.19	5.95	.42	.21	.27
	Relative emphasis	.47	.41	.70	.88	.49	.50
	Expected genetic gain	.134	.076	1.785	.055	.008	.105
Ewes	Advantage of selected lambs	.09	.09	1.93	.22	.11	.11
	Relative emphasis	.18	.20	.23	.46	.26	.20
	Expected genetic gain	.050	.036	.579	.029	.004	.043
Annual rate of improvement from weaning selection	1945	.025	.015	.318	.011	.002	.020
	1944	.020	.011	.233	.009	.002	.030

About 22 percent of the ram lambs and 69 percent of the ewe lambs retained in the selected groups. The relative emphasis placed on each trait was calculated by dividing the selection differential by the standard deviation for that trait. The greatest efforts in selection at weaning age were placed on type and body weight. Emphasis on face covering and length of staple increased over 1944 while there was decreased emphasis for neck folds of ewe lambs.

The expected genetic gain from selecting ram lambs and ewe lambs was obtained by multiplying the selection differential by the heritability for the corresponding trait. These figures are estimates of how much the selected group are superior in actual breeding value to the unselected groups from which they were chosen. These gains may be changed through later selection. They are particularly apt to be increased for the rams since less than 1/5th of the rams saved at weaning age are usually used in breeding.

If no additional selections were practiced on these lambs, the annual rate of improvement would be the sum of the genetic improvement in the ram lambs and the ewe lambs divided by their total age (7.43 years) when their offspring are born. The annual rate of improvement from weaning selections increased for each trait in 1945 over 1944 with the exception of condition and neck folds. The greatest increase was noted for weaning weight, staple length and face covering, all of which have considerable economic importance. These improvements are probably largely due to the use of a selection index in 1945 although the proportion of lambs retained was slightly lower in 1945 as compared with 1944. The decreased rate of improvement for neck folds appeared to be due to a reduction in variability of neck folds as the lambs approached the desired goal in smoothness.

PROGRESS IN SELECTING FOR SMOOTHNESS WITH RAMBOUILLETS

Selection for smoothness in preference to wrinkles or folds of the skin is now a common practice in Rambouillet flocks. Smooth Rambouillets generally produce longer staple and more uniform fleeces than those with wrinkles. Weights of clean fleece from smooth-bodied ewes are about equal to those from wrinkled ewes although the latter may produce heavier grease fleece weights. Smooth sheep are more easily sheared, are less subject to fly trouble and produce more valuable skins than wrinkled sheep. Purchasers of feeder lambs often discriminate against lambs with wrinkles or folds.

Efforts to eliminate skin folds from the Rambouillet flock have been very successful. The flock is now rapidly nearing the point where emphasis on skin folds will be less necessary. Thus, one goal in the improvement of Rambouillets will be achieved after only a few generations of selection. When it has been accomplished, it will permit increased attention to other traits such as body weight, fleece weight, staple length and face covering.

The gain in smoothness in 2 generations has been approximately one score. That is, the average neck fold score of all weanling offspring from Rambouillet lines has changed from 2.4 to 1.4 in 8 years. A score of 1 represents complete absence of folds while a score of 5 indicates maximum skin fold development. The percent of weanling lambs showing moderate to heavy folds has decreased from about 39 percent in 1938 to 5 percent in 1945. Furthermore those lambs with practically no folds have increased from 20 to 77 percent in the same period.

SELECTION FOR OPEN FACE IN RAMBOUILLETS

Progress in increasing the incidence of open face in the Rambouillet flock has been difficult. Average weanling face covering scores of all offspring reveals a slight trend in the direction of more covered faces. This may be due to a shift in scoring standards as it is very difficult to hold to strictly comparable standards from year to year. We may be getting more critical and therefore score them harder each year. The overall appearance of the flock shows improvement.

Because of this failure to demonstrate definite progress in the fixing of open face it has been necessary to take steps to increase the selection differential for open face. The use of a weanling selection index in 1945 was very helpful. In that fall the selection differential for open face was increased by 14 percent for ram lambs and by 80 percent for ewe lambs.

Another means of increasing progress for open face which was initiated in 1945 consisted of changing to the use of a ram lamb wherever the best ram lamb in the line had a more open face than the best older ram available. In 1944 the average weanling score for face covering of rams used in lines was 4.33. In 1945 by shifting to ram lambs in 11 lines this could have been reduced to 3.84. However, in 1945 most of these lambs were not sufficiently mature for breeding but some further gain was made by placing more emphasis on open face in the selection of older rams for breeding. The actual average for rams used in 1945 was 4.05 which represented a definite gain in the selection differential. The estimated total genetic progress toward open face from selection of both rams and ewes in 1945 was much greater than in 1944.

POLLED RAMBOUILLETS

The two polled lines (53 and 54) have now produced a total of 191 weanling offspring. Frequency of offspring in the various classes from the different matings are shown in the following table:

Parents	Horned rams	Polled rams	Ewes with knobs	Polled ewes
Horned rams X polled ewes	6	10	11	14
Polled rams X ewes with knobs	8	3	7	6
Polled rams X polled ewes	10	52	13	43
Polled rams X polled ewes (with polled sires)	0	3	2	3

Offspring from daughters of polled parents were produced for the first time in 1945. These are shown in the last line of the above table.

Two polled rams were used in test pens in 1944 being mated to ewes which all had horn knobs. One ram produced 5 polled ewe offspring and 5 with horn knobs while the other produced all polled (10) ewe offspring. Ram lambs had all been castrated. It was concluded that the first ram carried a horned gene and that the second ram probably did not. This second ram was used in line 54 in 1945.

PROGENY TESTING OF RAMBOUILLETS

Ewes available for progeny testing of Rambouillet rams from inbred lines were reduced from 464 in 1944 to 92 in 1945. This reduction was necessary chiefly because of the increased feed costs. Consequently the number of rams tested was reduced from 22 to 5.

It appears for practical purposes that about 16 weanling offspring are sufficient to evaluate a sire. Therefore, the number of ewes bred to each test ram has been reduced to 18.

MERINO RAMBOUILLET CROSSES

A New Zealand Merino ram was purchased and a preliminary test was initiated to determine whether it would be desirable to introduce Merino blood into one or more Rambouillet lines.

The Merino ram obtained was somewhat smaller and showed more skin folds than Rambouillet rams. He had an open face and produced a 1/2 Blood fleece with a staple length of nearly 4 inches. The grease fleece weight was about the same as average Rambouillet ram fleeces but the clean weight was somewhat higher. This ram was mated to 9 selected Rambouillet test ewes and some ewes of crossbred breeding in the fall of 1945. Further matings will be determined according to the merits of the offspring produced this year.

THE COVARIANCE ANALYSIS OF MULTIPLE CLASSIFICATION TABLES WITH UNEQUAL SUBCLASS NUMBERS

In experimental work with range sheep it is often desirable to determine the simultaneous effect which factors such as type of birth and age of dam may have on the various traits used in evaluation of merit. In classifying sheep records, unequal numbers will invariably be found in the subclasses. It is also desirable to determine the effects of factors such as age and inbreeding which exhibit continuous variation. A method has been developed for the purpose of analyzing data where independent variables and multiple classifications with unequal subclass numbers occur in the same data. This method is an extension of that of fitting constants and is specifically designed to eliminate, from the estimate of the effect of each factor, possible inequalities due to the other factors insofar as this is possible.

INCREASING ACCURACY OF SELECTION IN YEARLING RAMBOUILLET EWES

The effects of age of dam, type of birth, year of birth, breeding group, and age at shearing were studied on 932 range Rambouillet yearling ewes, born in 1941 and 1942.

Grease fleece weight, clean fleece weight, yearling body weight and staple length, which were evaluated by a quantitative standard were more strongly influenced by environmental factors than were condition, neck folds, body type and face covering, which were evaluated by scoring.

Yearling ewes from mature dams and singles were heavier, had longer staple and produced heavier grease fleeces and more clean wool than those from 2-year-old dams and twins, respectively.

It was found that accuracy of selection on yearling traits could be increased by adjusting staple length for type of birth; grease fleece weight for age of dam, type of birth and age at shearing; clean fleece weight, body weight and type score for type of birth; and condition score for age at shearing. Adjustment of face covering and neck folds scores for environmental effects at yearling age was unnecessary.

EFFECT OF INBREEDING ON YEARLING RAMBOUILLET EWES

The effects of inbreeding were more pronounced on the mutton characters (body weight, type and condition) than on the fleece characters (staple length, grease fleece weight and clean weight). With each increase of one percent in the coefficient of inbreeding there was a decrease of 0.278 pounds of body weight, 0.019 pounds of grease fleece weight, 0.011 pounds of clean fleece weight and 0.009 centimeters in staple length. Body type and condition scores became poorer by 0.011 and 0.007 score, respectively, for each percent increase in inbreeding. The effect of inbreeding on face covering and neck folds was very small. The effects of inbreeding on body weight, body type and condition were of sufficient importance to warrant adjustment before making yearling selections. The average range of inbreeding among the progeny of each line in one year is about 25 percent. Thus on the average the least inbred ewe in a line might be 7 pounds heavier than the most inbred ewe simply because of the difference in degree of inbreeding.

THE EFFECT OF AGE ON FLEECE PRODUCTION OF RAMBOUILLET RAMS

A study was made of the lifetime fleece records (1st 5 years) of 502 Rambouillet rams born during the years from 1938 to 1942

inclusive. This information will be useful in adjusting ram records to a standard age. The results are shown in the following table:

Age in years	No. of rams	Grease fleece weight (lbs.)	Commercial clean fleece weight (lbs.)	Staple length (cm.)	Change of records in each year over those of same rams in previous year: Grease fleece weight (lbs.)	Clean fleece weight (lbs.)	Staple length (cm.)
1	502	12.58	5.50	6.95			
2	253	14.96	7.05	7.48	+2.14	+1.31	+.51
3	146	16.67	7.94	7.95	+1.25	+ .52	+.33
4	65	16.21	8.36	8.13	- .65	+ .44	+.15
5	26	16.23	7.78	7.76	+ .82	- .05	+.07

The first year includes about 13.5 months growth while later years are for approximately 12 months.

Grease fleece weights were heaviest in the third year of age while clean fleece weights were heaviest in the fourth year. Length of staple was also greatest in the fourth year when all records were considered. When each year's change was restricted to rams which were present both years (right hand portion of table) it is noted that staple length was still increasing in the fifth year.

The data in the left hand portion of the table includes the effects of selection. In general about 50 percent of the rams were retained each year. For earlier ages the rams retained for another year nearly always excelled the group from which they were selected for each trait. After the 3rd or 4th year of age this was reversed. Evidently factors such as death, unsoundness, infertility and progeny records were more important in determining which older rams remained in the flock than the ram's own records.

The change of records in each year over those of the same rams in the previous year are given in the right hand portion of the table. For instance the 253 rams available as 2-year-olds had an average grease fleece weight of 14.96 pounds. These 253 rams sheared an average of 12.82 pounds as yearlings as compared with 12.58 pounds for all yearlings. The gain of 2.14 pounds may be more representative of the change from yearling to 2-year fleeces than the difference of 2.38 pounds between all yearling and all 2-year-olds. Neither difference is free from the effects of selection as the yearling records from the selected group are more apt to contain individual records which are abnormally high because of temporary causes.

REFINING METHODS FOR EVALUATING SEMEN IN THE PREDICTION OF FERTILITY OF RAMS

The object of this study was to test the value of opal blue as a differential stain for ram sperm. Improvements in the opal blue smear technique and the development of new methods for increasing its usefulness were sought. The feasibility of estimating concentration, percent live sperm and percent abnormal sperm in one operation with the hemocytometer by incorporating opal blue into the diluter fluid, was tested. The data for these studies were collected in 1942 but the analyses of the data were not completed until recently.

The optimum stain mixture for opal blue Breslau and eosin was found to be: 12.5 percent opal blue and 0.5 percent eosin in pH 7.15 phosphate buffer. It was necessary to stain 30 seconds before smearing. No suitable method was found to incorporate opal blue and eosin stain into the hemocytometer diluter.

Agreement of workers was significant for counts of normal spermatozoa, but differences were significant for concentration counts. Conditions of sampling were responsible for the differences.

Prediction of percent live normal spermatozoa (in the smear) from a combination of the motility score and estimated percent motile spermatozoa had significant reliability. The reliability of this relation was confirmed, using a sample of the 1942 semen testing records.

Important morphological abnormalities of spermatozoa were present in several of the rams used in breeding pens in 1941 and 1942. These rams exhibited reduced fertility or complete sterility. Elimination, from the records of the 1942 breeding season, of all rams with 50 percent or less live normal spermatozoa and more than 1 percent abnormal heads increased the percent of ewes pregnant by 3.3 percent, a significant increase.

REPRODUCTIVE CAPACITY OF RAMBOUILLET RAMS

Semen tests were made on all Rambouillet rams used for breeding in 1945. A total of 134 ejaculates were examined from 48 rams. Nine rams were rejected because of poor quality semen. The semen from the remaining rams appeared to be above average in quality. All rams used in breeding pens appeared to be of satisfactory fertility.

Preliminary tests were continued on the use of a photoelectric colorimeter for the determination of sperm concentration. Dilution of 0.1 cc. of semen in 10 cc. of a 4 percent solution of chlorazene was thought to be satisfactory. Dilutions showed some change on standing so that colorimeter readings need to be made within a few minutes after dilution of the semen. A tentative regression equation was developed for estimating sperm concentrations from the colorimeter readings. Colorimeter readings using different concentrations of sperm cells and fluid showed additive effects of sperm cells and fluid.

CLEAN WOOL YIELD DETERMINATIONS

A total of 230 wool samples were scoured during the year. These samples were scoured at the wool Laboratory, Beltsville, Maryland because the wool technologists were not released from the armed forces until the early part of 1946 and the scouring information was needed by September of 1945 before the current breeding season matings were made.

The percentage of clean yield from the small side sample was used in determining the total amount of clean wool in each fleece.

Clean fleece weights of yearling ewes were estimated from grease fleece weights and staple lengths.

WOOL QUALITY

Wool samples were taken from the side, back and hip of all Rambouillet yearling ewes and all rams for the determination of fineness, uniformity and medullation. These samples were blended with a pair of hand sampling cards and one cross section made for analysis. Approximately 500 determinations have been made since wool technologists have returned from military service. There remains about 14,000 more determinations to do before all of the past years samples will be complete due to the war years interruption.

WOOL FILM STRIP REVISED

The first 35 mm. film strip of wool standards developed at this Laboratory in 1939-40, for use in estimating wool fineness and variability by the rapid comparator method has been revised. The new revised strip was accomplished in May 1946 and is quite an improvement for many of the examples over the first strip developed, as to distinctness, clarity and usability. These film strips are printed on 35 mm. double perforated positive film and are about 5 feet long. The standards cover the complete range for domestic wool grades (80's-36's) and fineness readings are made in microns from the projected strip so they may easily be converted to the English spinning count or a numerical grading system. It is necessary to have a satisfactory 35 mm. projector, and a microscopic set-up or a microprojector to cast the image of the unknown sample in question that has been cut in a cross-section device, to a magnification of 500 diameters. The method is described in U.S.D.A. Circular 704, "Sampling and measuring methods for determining fineness and uniformity in wool". The new revised film strips are available upon request by the collaborating stations in exchange for strips they now have.

BLENDING SAMPLES OF WOOL

In recent tests on blending small staples of wool by hand carding it was found that after 10 strokes of the cards the mixture was definitely non-random. It seemed probable that a random mixture could be achieved frequently after 20 strokes but with reasonable certainty only after 30 strokes. The new data on these tests will be presented in the revised circular 704. Revision of this circular is going forward at this time.

WOOL PRODUCTION OF RAMBOUILLET YEARLING EWES

Summaries of wool production of Rambouillet yearling ewes for the past 5 years adjusted to 365 days growth are given in the following table.

Years	1945	1944	1943	1942	1941
Fleece Characters	Mean	Mean	Mean	Mean	Mean
Fleece weight (grease) lbs.	8.95	8.61	8.05	7.89	9.34
Fleece weight (clean) (bone dry) lbs.	3.46*	3.51*	3.18*	3.52	3.40
Commercial for breed	3.93	3.99	3.61	4.00	3.86
Clean yield (Bone-dry) %	38.66	40.77	39.87	44.61	36.43
Commercial for breed	43.91	46.30	45.31	50.70	41.40
Staple length (cm.)	6.66	6.42	6.47	6.13	5.99
Staple length (inches)	2.62	2.53	2.55	2.41	2.36

* Estimated from nomograph by use of grease fleece weight and staple length.

The grease fleece weights in 1945 were above the average for the past five years and the clean fleece weights were also above average, being excelled only in 1942 and 1944. Staple length for the entire flock has shown an increase for every year but one during the past five years.

LONG STAPLE LINE

Summaries of wool production (adjusted to 365 days) for yearling ewes from line 21 originally selected for long staple are given in the following table.

LONG STAPLE LINE

Year	No. of head	Staple length (cms.)	(inches)	Grease fleece weight (lbs.)	Clean fleece weight (lbs.)(Bone-dry)
1939	11	6.51	2.56	9.30	3.14
1940	16	6.78	2.67	9.55	3.81
1941	8	6.63	2.61	10.21	3.76
1942	7	7.21	2.84	8.05	3.98
1943	7	7.56	2.98	7.43	3.40
1944	7	7.09	2.79	8.19	3.60
1945	6	7.29	2.87	9.72	3.88

When the fleece values are compared with those in the preceding table for the average of all lines it will be noted that the long staple line excells for each wool character listed.

In 1945, 5 of the yearling ewes produced fleeces grading Fine Staple Combing and 1 graded Fine French Combing.

PERCENT OF FLEECES IN EACH GRADE FOR RAMBOUILLET RAMS AND EWES 1942-1945

	Yearling			Mature		
Sex	Fr.	S.	1/2	Fr.	S.	1/2
Rams	6	92	2	6	92	2
Ewes	21	75	4	47	50	3

The above figures present the commercial grading of the Rambouillet fleeces for four years. This information is valuable when applied to sheep for selection purposes and also for good wool marketing practice. These same fleeces were sacked and scoured according to grade and the scouring results for 1945 will be found elsewhere in this report. It will be noted that the rams grade a higher percentage Fine Staple Combing which shows they are more highly selected than are the ewes. However, ram fleeces are usually stronger and have a longer staple. Rambouillet rams whose 12 months fleece growth does not grade Staple should not be used for breeding purposes unless they may be old aged rams whose production peak is past. Fine Staple Combing wool usually sells for about five cents more per clean pound than does average Fine French Combing.

GRADING, CLEAN YIELD AND VALUE OF FLEECES IMPORTANT

The percentage of fleeces grading Fine Staple Combing is steadily increasing over the Fine French Combing from year to year as may be noticed in the column of percentage of total in the next table both for the yearling and mature ewes and also the rams. By comparing the percentages with those in a preceding table showing the four year average grading percentage, there is evidence of improvement for increased wool production. The grading report is pertinent information for wool producers, breeder's and research workers in presenting data as to the most productive and profitable sheep to produce. By examining the last column in the table--net fleece value Dubois--it is seen that the Fine Staple Combing fleece was worth .75 cents more than the Fine French for the yearling ewes. In every case the Fine Staple fleeces had a higher net return than did the Fine French because they have a longer staple length, a heavier grease weight, a higher clean yield and a higher appraised value per pound. This information is of importance to the ranch wool producer so that he may know the most economical sheep to retain in his breeding flock.

SHRINKAGE AND APPRAISAL OF 1945 GRADED CLIP

As each fleece was graded it was put into its respective bin for sacking. Each fleece was sacked according to grade and sex. Each grade lot was scoured individually and an individual shrinkage and appraisal value reported on each lot. There were 13 main lots for the ewes and rams and 4 miscellaneous lots. All lots except the 1/4 Blood were sorted into a No. 1 main sort, a burry sort, paint sort and low-stained or grey sort. The percentage of the main sort to the total wool in the entire lot ranged from 90% in the Fine Ram wool to 74% in the 3/8 Blood Yearling ewes. The mature and yearling ram wool was made into one lot for each grade. Since this wool is very similar in quality and shrinkage and in order to cooperate with the mills desire they were combined because the lots were small and the commercial scouring plants do not care to handle any smaller lots than is practical for their operations.

The 1/4 Blood lots were not sorted because the sorting foreman stated that due to the high quality and great uniformity, there would be but a very small portion of offs and it would not raise the sale value of the wool enough to be worthwhile. The mill was very crowded for space and time so it was agreed to be satisfactory but as it becomes possible to have complete sorting accomplished this will give more thorough information on the entire clip and conform to the Bureau's desire.

It will be noted in several cases that the burry sort had a higher yield than the main sort, but this was not true for the majority of the lots. Perhaps the higher yield in the burry sort may be attributed to a certain portion of the dirt sifting out when

COMMERCIAL GRADES, WEIGHTS AND COMMERCIAL CLEAN YIELD OF RAMBOUILLET FLEECES FOR 1945*

Grade	No. fleeces	% of total	Grease fleece weight (lbs.)	Clean yield (%)	Clean fleece weight (lbs.)	Appraised clean value ($)	Net grease price Dubois ($)	Net fleece value Dubois ($)
YEARLING EWES								
Fine French Combing	35	8	9.2	44.0	4.0	$1.22	$0.49	$4.51
Fine Staple Combing	359	86	10.3	45.4	4.7	1.23	.51	5.25
1/2 Blood Combing	23	6	11.1	47.7	5.3	1.22	.54	5.99
Totals and Average	417		10.2	45.44	4.6	1.23	.52	5.30
MATURE EWES								
Fine French Combing	631	39	10.3	45.22	4.7	1.22	.51	5.25
Fine Staple Combing	944	58	10.9	49.04	5.3	1.24	.56	6.10
1/2 Blood Combing	58	3	11.5	51.15	5.9	1.21	.58	6.67
Totals and Average	1633		10.7	47.70	5.1	1.23	.54	5.78
YEARLING RAMS								
Fine French Combing	2	2	10.6	43.0	4.5	1.22	.48	5.09
Fine Staple Combing	94	96	12.9	44.0	5.7	1.24	.50	6.45
1/2 Blood Combing	2	2	17.5	44.3	7.5	1.22	.50	8.75
Totals and Average	98		12.9	44.0	5.7	1.24	.50	6.45
MATURE RAMS								
Fine French Combing	2	2	16.5	43.0	7.1	1.22	.48	7.92
Fine Staple Combing	98	98	17.1	44.0	7.5	1.24	.50	8.55
Totals and Average	100		17.1	44.0	7.5	1.24	.50	8.55

* The paint, low and stained sorts, crutchings and tags have been proportioned in all fleece weights and clean yields. The yearling ewes and rams were not crutched. The net grease price figure has been rounded to the nearest cent.

the sorters pulled the burry wool from the main sort. In every case, however, the clean scoured wool in the main sort was appraised 4 to 10 cents higher per clean pound than was the burry. The burry sort made up but a small portion of the total, however.

The 1/2 Blood mature ewe wool had the highest net grease value for all grades, followed by 3/8 Blood and Fine Staple Combing. The increased yield in the 1/2 Blood lot and only a one cent lower appraisal value than for the Fine Staple is what brought the grease price above the Fine. Great emphasis should be placed on the amount of clean wool in fleeces of breeding sheep because it is not always the sheep that produce the heaviest grease fleeces that are the most productive in dollars and cents, although heavy grease fleeces are good indicators.

The cost of marketing, processing, service and appraisal on the 1945 clip was as follows: The freight charge was 2.38 cents per pound and a handling charge of 1.97 cents per pound or a total charge of 4.35 cents per grease pound for freight and handling. The sorting charges amounted to 1.75 cent per pound and the scouring charges of 3.54 cents per pound making a total of 5.29 cents per grease pound for processing. Service and appraisal charges by the CCC were 1.30 cent per grease pound, plus 1% of the scoured clean price, or 0.54 cent per grease pound or a total of 1.84 cents per pound for service and appraisal. This makes a total charge of 11.48 cents per grease pound for marketing, processing, service and appraisal.

RELIABLE SHRINKAGE IMPORTANT

The so-called pioneering work accomplished by the BAI in the past relative to wool shrinkage as it relates to price and net returns to the producer or rancher has set the stage for greater studies in determining shrinkage of ranch wools. The first domestic bagged wools that were cored by the old Agricultural Marketing Administration were produced, graded and bagged at the Western Sheep Breeding Laboratory and U. S. Sheep Experiment Station. Through a cooperative wool shrinkage program with this organization the wools were cored, shrinkage determined and the BAI went ahead and had each grade and lot of wool scoured in its entirety and the results of each method were compared. Since 1941 when the first coring work was done the method has been improved to the point where a very reliable shrinkage figure is arrived at with an accuracy of a plus or minus 1%. This, when compared to the visual estimates placed on wools by an appraisal committee shows that core samples from bags gives a much more accurate figure than the visual means of determining values. The coring work has progressed to the point where the Commodity Credit Corporation accepts the results from core samples as being the shrinkage upon which they rely for all re-appraisals.

CLEAN YIELD AND APPRAISAL VALUES ON GRADED AND SORTED CLIP FOR 1945

Grade Lot	W.F.A. APPRAISAL VALUE ON SORTED & SCOURED BASIS					
	Main Sort*		Net grease value f.o.b. Dubois	Burry Sort		Net grease value f.o.b. Dubois
	Clean yield (%)	Value		Clean yield (%)	Value	
MATURE EWES						
Fine French Combing	45.81	$1.24	$0.52	46.34	$1.16	$0.49
Fine Staple Combing	50.56	1.26	.59	46.31	1.20	.51
1/2 Blood Combing	52.94	1.25	.62	48.54	1.17	.52
3/8 Blood Combing	55.30	1.16	.60	53.31	1.10	.54
1/4 Blood Combing	55.45	1.05	.54	not sorted		
YEARLING EWES						
Fine Staple Combing	46.91	1.25	.54	42.92	1.19	.47
1/2 Blood Combing	47.48	1.25	.55	49.73	1.20	.55
3/8 Blood Combing	54.41	1.16	.59	49.08	1.09	.49
1/4 Blood Combing	53.12	1.02	.50	not sorted		
RAMS -- MATURE AND YEARLING						
Fine Staple Combing	44.54	1.25	.51	41.06	1.21	.45
1/2 Blood Combing	45.54	1.25	.53	41.88	1.15	.44
3/8 Blood Combing	48.81	1.16	.52	56.09	1.08	.56
1/4 Blood Combing	50.59	1.03	.48	not sorted		
MISCELLANEOUS LOTS						
Fine Wool Crutchings	41.68	1.07	.40			
Cross-bred Crutchings	47.79	.98	.42			
Grading Locks & Tags	36.05	1.00	.32			
Black, Brown and Gray	45.02	.84	.33			

* The paint, low and stained sorts were averaged with the main sort in determining clean yield and price. However these sorts made up but a small portion of the total.

Through cooperative wool shrinkage studies and core testing of Bureau wools and also from some state experiment stations who are cooperating on this work with the Production and Marketing Administration (old AMS) certain states have pointed out where their producers are realizing upwards of a million and a half dollars in increased returns per year. This has come about by proof of actual shrinkages where wools had been pegged for certain localities of far too high a shrinkage percentage in years past.

LOSS IN WEIGHT FROM DUBOIS TO CAMDEN AFTER STORAGE

The Dubois 1945 wool clip, consisting of 157 bags and a total weight of 47,585 pounds at shearing time were loaded on June 13 and shipped via rail to Camden, New Jersey. The shipment arrived in Camden on June 25 at which time each bag was weighed out of the car. The shearing floor weights and Camden weights were compared, bag for bag, and found that 36 bags weighed the same each time, 47 gained an average of 2.1 pounds per bag and 74 lost an average of 1.7 pounds. The net loss for all 157 bags averaged 0.1656 pound per bag or 0.05 percent of the total weight at shearing time.

The entire clip was stored at Camden, New Jersey from June 25, to November 6 until it was sorted and scoured by grade. As the wool came up for sorting, each bag was weighed. A comparison of 127 bags containing the 10 main lots was made between the Dubois shearing weights and the November 6 weights after it had been stored on the East coast for about 4 months. Five bags weighed the same as at shearing time, one had gained 2 pounds and the other 121 bags lost an average of 6.372 pounds per bag, and for all 127 bags the net loss was 6.055 pounds per bag which amounts to 1.987 percent of the total weight of these 127 bags at shearing time.